Annual Report

Period Covered by the Report: 8/1/2007 – 7/31/2008

Date of Report: 11/1/2008

EPA Agreement Number: RD-83340101-0

Title: Promoting sustainable pollutant control policies through consideration of social and biological indicators: An application to mercury control in New England

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Institution: Dartmouth College, Hanover, NH

Research Category: Collaborative Science and Technology Network for Sustainability

Project Period: 8/1/2007 – 7/31/2010

(1) Progress:

The objectives of our project are the following:

1. To identify meaningful biological and social indicators of sustainability that can be linked with mercury control policies using available knowledge and data.
2. To determine whether the establishment of an explicit connection between mercury policy and biological and social indicators will increase the motivation for individual and organizational stakeholders to act in ways that promote ecological, economic, and social sustainability.
3. To assess whether the monitoring and reporting of biological and social indicators is likely to improve resilience in the human-environment system by improving stakeholder perception of ecological change, enhancing learning, and facilitating the process of adaptive management over time.

The timetable below indicates our original proposal's schedule for progress on these three objectives, including specific tasks. As can be seen in the table, continued progress has been made in Year 02 on objectives 1 and 2, especially with regard to developing a list of sustainability indicators and developing and testing the stakeholder surveys that have replaced the experimental games portion of our project in addressing objective 2. In addition, we have added a new element to our project for addressing objective 2 which involves a formal analysis of public comments received on the Clean Air Mercury Rule (CAMR).

There are two elements of our project that continue to be behind schedule after Year 02: the development of the integrated model required for objective 1 and the implementation of our stakeholder surveys. These will each be discussed in turn.

Regarding the development of our integrated model, we continue to rely in large part on the data and submodels produced by the MERGANSER project of EPA Region 1 and USGS. We have continued to be in active communication with the MERGANSER project team, including participation in regular meetings. However, the MERGANSER project has continued to be significantly delayed, and their data and model products intended to be ready in Spring/Summer 2009 are not yet available. The current estimate is that these products will be available by December 2009. We therefore plan to shift major work on this task to Year 03 of the project and anticipate the possibility of needing to request a no-cost extension to complete this task. This decision will be made early in 2010, based on when we receive the MERGANSER products.

As described in the Year 01 progress report, we have replaced our plans for experimental games with a survey-based study of the role of indicators to motivate individual pro-environmental

behavior. We have carefully investigated the theoretical and empirical basis for this approach and have written a review paper on the topic which has been accepted for publication after peer review. We have also designed and extensively tested our survey instrument on Dartmouth undergraduates, and after two rounds of modification we are ready to implement it on a wider scale. We feel that this new element will add significant value to our project.

Table 1: Timeframe of project objectives and specific tasks as included in the original proposal (with start date adjusted according to actual start date of August, 2007). Text indicates planned stages, shaded cells indicated completed stages as of the end of Year 02.

OBJ	SPECIFIC TASKS	YEAR ONE		YEAR TWO		YEAR THREE	
		F/W '07	Sp/S '08	F/W '08	Sp/S '09	F/W '09	Sp/S '10
1	a. Review literature and develop indicator criteria	Initiated	Completed				
	b. Develop list of indicators		Initiated	Major Task	Completed *		
	c. Acquire data and submodels	Major Task	Final Stage	Completed			
	d. Develop environmental model		Major Task	Major Task	Final Stage	Completed *	
2	a. Review literature and perform initial scoping interviews	Initiated	Completed				
	b. Conduct interviews with EJ groups and summarize results		Initiated	Major Task	Completed *		
	c. Develop and test **stakeholder surveys**		Major Task	Completed			
	d. Conduct **surveys** and summarize results			Initiated	Major Task	Completed *	
	e. Formal analysis of public comments on CAMR			Initiated	Data Collection	Analysis	Completed *
3	a. NSECPMS Case Study				Initiated	Major Task	Completed *
	b. Synthesize results					Initiated	Major Task *

(2) Personnel changes

In fall 2008, Darren Ranco left Dartmouth to take a position at the University of Maine. While Ranco continued conducting his interviews with EJ groups, close coordination became more difficult. For this reason, it is likely that the comparison between our surveys of the general public and the EJ group interviews will be more qualitative than originally planned.

As described in the last progress report, much of Borsuk's salary support was shifted to Post Doctoral Research Associate, Rama Mohana Turaga, who was employed for 2.0 months in Year 02 of the project.

(3) Expenditures

The slight delays associated with the shift in our experimental design, as well as additional delays with the MERGANSER project led to expenditures somewhat less than planned. A total of $177,432.90 has been spent through Year 02 compared to $200,885 which was budgeted. This is approximately consistent with the proportion of our aims achieved to date, as shown in the timetable above. We do have some concerns looking ahead regarding funds for the implementation of our survey. This is described in detail in the attached document outlining the rationale and estimated budget for our survey.

(4) Quality assurance

Our integrated model development relies on data and submodels from the MERGANSER project. They have been following a QA/QC procedure which will be included in the documentation for our model.

Regarding our coding and analysis of public comments on CAMR, we have developed a set of guidelines and table of keywords to be identified in each comment. These keywords have been located and annotated by two students, replicating each other's work as a control against errors. The duplicate codings were then reviewed by a post-doctoral Research Associate to resolve any inconsistencies. In the next step, the data will be analyzed statistically using appropriate methods.

Regarding our planned survey, we have applied for and obtained approval from Dartmouth's Committee for the Protection of Human Subjects (CPHS). Our application to CPHS includes a description of the methods we will be using for collecting, organizing, storing, and analyzing our survey data.

(5) Results to Date

In Year 02, we accomplished the following results: (1) developed a preliminary list of sustainability indicators based on the criteria we established in Year 01, (2) continued our interviews with EJ groups, focusing on the Penobscot Nation in Maine, (3) gathered, organized, and coded in duplicate 1000 public comments received by the EPA on CAMR, (4) developed and extensively tested the survey portion of our project, and (5) initiated the NSECPMS case study. We will focus here on result (3), the development and testing of our survey, as that is a novel aspect of our project that provides the foundation for much of our work in the coming year.

Our survey questions and questionnaire format have been developed in accordance with guidelines from the latest survey research. We have pre-tested our questionnaire with undergraduate students from the Dartmouth campus. We collected more than 60 completed questionnaires in our first round of test surveys. We modified the questionnaire based on the analysis and feedback from the initial set of test surveys. We then conducted a second round of test surveys, yielding approximately 40 more completed questionnaires.

One important result of our survey is the classification of individuals according to their primary objects of concern regarding environmental protection (e.g., self, other humans, the biosphere). This is assessed based on the respondents' relative agreement with a set of diverse value statements. Factor analysis of our preliminary survey data indicates that three basic value orientations (egoism, social altruism, and biospherism) can be clearly distinguished among the student population we studied. If confirmed in the larger survey, these constitute an important precursor to how receptive respondents are to various types of environmental indicators.

The treatment variable used in our survey is the indicator information provided. Half the surveys contained indicators of mercury contamination intended to strengthen beliefs concerning personal responsibility, and half contained control indicators (e.g. indicators normally used by the EPA) without any explicit link to personal action. Respondents were then asked questions about their willingness to engage in certain mercury reducing behaviors (including correct disposal and recycling of mercury containing products and enrollment in a green energy program). In this small sample, it was encouraging to find that statistical analysis demonstrated a significant effect on intended behavior (in the expected direction) of receiving the enhanced indicator relative to the control indicator after accounting for the person's value orientation and perceived time, cost, and effort of the behavior. This is a preliminary result, but it indicates that stakeholder beliefs and behavior can be positively influenced by targeted, context-specific information. The attached document contains details on these preliminary survey results.

(6) Planned Activity

In Year 03 of the project, our emphasis will be on conducting our survey and making progress with the integrated environmental model based on the MERGANSER results. We will also be analyzing the public comment data. The results of these efforts will be compared and contrasted with the stakeholder interview results and the list of sustainability indicators. The NSECPMS case study will then provide a framework for integrating these findings in a specific context.

(7) Publications and Presentations

Turaga, R.M.R., R.B. Howarth, and M.E. Borsuk. In press. Pro-environmental behavior: Rational choice meets moral motivation. *Ecological Economics Reviews*.

King, A.A., and M.L. Barnett. 2008. Good fences make good neighbors: An institutional explanation of the benefits of industry self-regulation. *Academy of Management Journal* 51(6): 1150 - 1170.

Ranco, D.J. 2008. The trust responsibility and limited sovereignty: What can environmental justice groups learn from Indian Nations? *Society and Natural Resources* 21 (4): 354-362.

Turaga, R.M.R. 2008. Hot spots regulation and environmental justice. Presented at the *Thirtieth Annual APPAM Fall Research Conference*, Los Angeles, CA, 6-8 Nov 2008.

Turaga, R.M.R. and M.E. Borsuk. Designing environmental risk indicators to motivate sustainable behavior. Presented at the *Annual Meeting of the Society for Risk Analysis*, Boston, MA, 7-10 Dec 2008.